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Received 23 April 2003; accepted 4 November 2003
Associate Editor: Ian G. Warkentin

J Raptor Res. 38(1):77–81

A RETROSPECTIVE STUDY OF MORTALITY AND REHABILITATION OF RAPTORS IN THE SOUTHEASTERN UNITED STATES

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KEY WORDS: *Injury; mortality factor; raptor; rehabilitation; release.*

Increasing habitat loss and fragmentation create more opportunities for humans and raptors to interact, often negatively affecting the birds. As a result, there is a need for rehabilitation facilities that can receive injured animals, treat wildlife, and release them back into the wild. In this paper we evaluate the effect that humans have on raptors by summarizing records of birds admitted to a raptor rehabilitation center. The records at these centers are valuable sources of data that provide current information on the animals, aspects of their natural history, and conservation.

We examine the following four questions within this paper: (1) are all raptor species equally likely to be released, (2) is the source of injury related to the likelihood for release, (3) do sources of injury differ between

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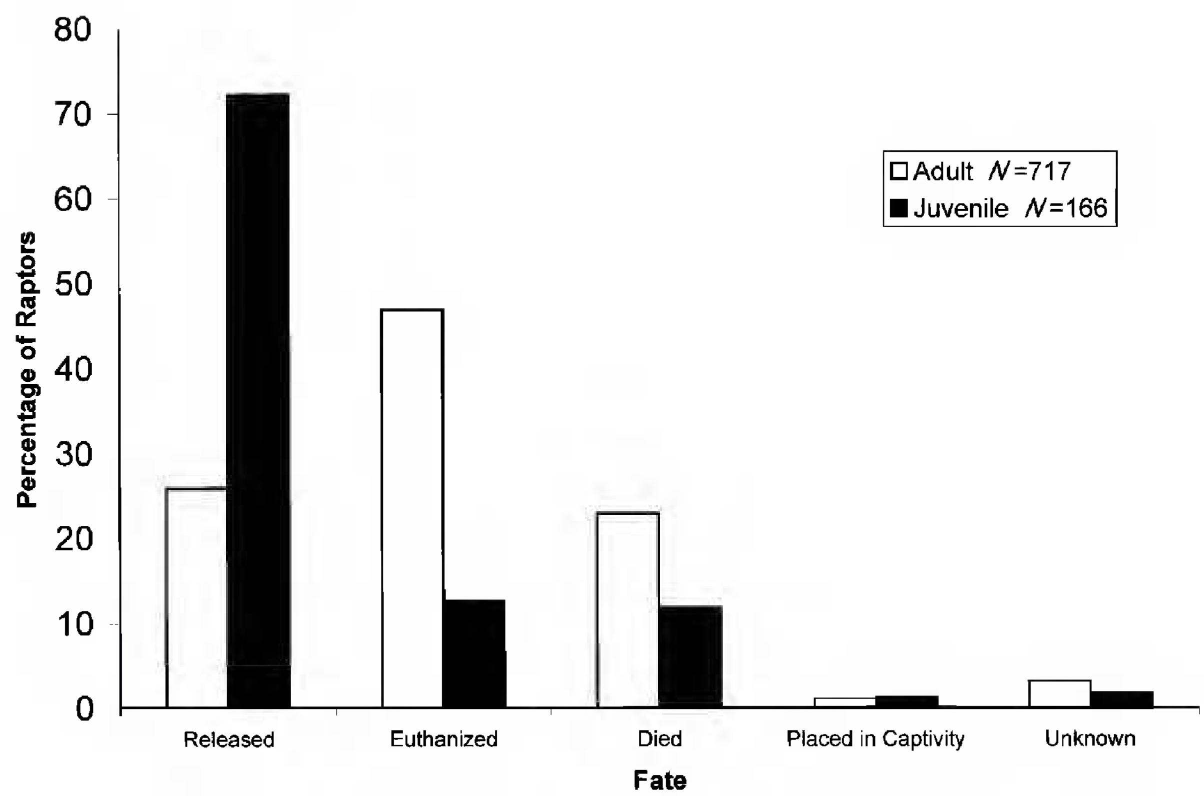

Figure 1. Final fates for raptors admitted to Southeastern Raptor Rehabilitation Center from 1 January 1999–6 December 2000. Unknown column signifies birds that were still retained at the rehabilitation center at the end of the study period. Birds received from falconers and zoos were omitted from analysis.

nocturnal and diurnal species and, (4) does body size affect survival of injured birds? For each question we examined adult and juvenile birds separately.

METHODS

We obtained data from the Southeastern Raptor Rehabilitation Center (SERRC), a facility located in Auburn, Lee County, Alabama. This facility receives injured and juvenile birds of prey from veterinary hospitals, rehabilitators, and other private individuals throughout the southeastern United States and occasionally from beyond this region. All records at SERRC from 1 January 1999–6 December 2000 were evaluated. Species, date admitted, case number, diagnosing injury, cause of injury, and final disposition of each bird were noted. A total of 896 raptors were admitted during this time period. Of these, 13 were omitted from further analysis because they were captive animals admitted from zoos, organizations that used them for educational programs, or by falconers. We then separated the remaining animals (N = 883) into two groups: adults, free-ranging animals with hard-pinned flight feathers and no known previous association with humans (N = 717), and juveniles, nestling or fledgling birds lacking hard-pinned flight feathers and that either were removed from a nest or found on the ground, presumably near a nest (N = 166).

In separate analyses for adults and juveniles, we categorized the causes of injury and determined the percentage of birds that lived or died within each by species. To test whether injury types occurred with equal frequency among all species we used G-tests (Zar 1996). For these analyses, the six species of adults with 25 or greater observations and the six species of juveniles with 10 or greater observations were included separately; adults or juveniles of all other species were pooled into a seventh category for analysis. We performed a second set of G-tests by pooling all owls into a single nocturnal-activity category of and all hawks into a single diurnal-activity category. The G-tests were used to determine whether injury types were distributed equally between the two activity categories for adults and juveniles. Finally, we used linear regression to examine the effects of adult body size on survival. For each statistical test alpha was set at 0.05

RESULTS

Adults were less likely than juveniles to be released (χ^2 = 122.1, df = 1, $P < 0.0001$; Fig. 1). Because animals donated to educational programs or retained by SERRC were deemed not suitable for release in the wild, we assumed that all of these birds plus those that were euthanized could not have survived; all released birds were considered to have survived their injuries. Therefore, the probability of death was 7.6× higher for adults than juveniles. For adults, there was a significant difference among species in their ability to survive (χ^2 = 20.7, df = 6, P = 0.002). This resulted because Eastern Screech-Owls (*Otus asio*), Great Horned Owls (*Bubo virginianus*), and Cooper's Hawks (*Accipiter cooperii*) were all more likely to survive injury than were Red-tailed Hawks (*Buteo jamaicensis*), Barred Owls (*Strix varia*), Red-shouldered Hawks (*Buteo lineatus*), and the category containing the rarer species. We found no significant difference among species in the ability of juveniles to survive (χ^2 = 8.5, df = 6, P = 0.20).

Of 19 different causes of injury to adult birds (plus unknown causes), we considered the five most common causes (hit by vehicle, collision/trauma, gunshot, barbed

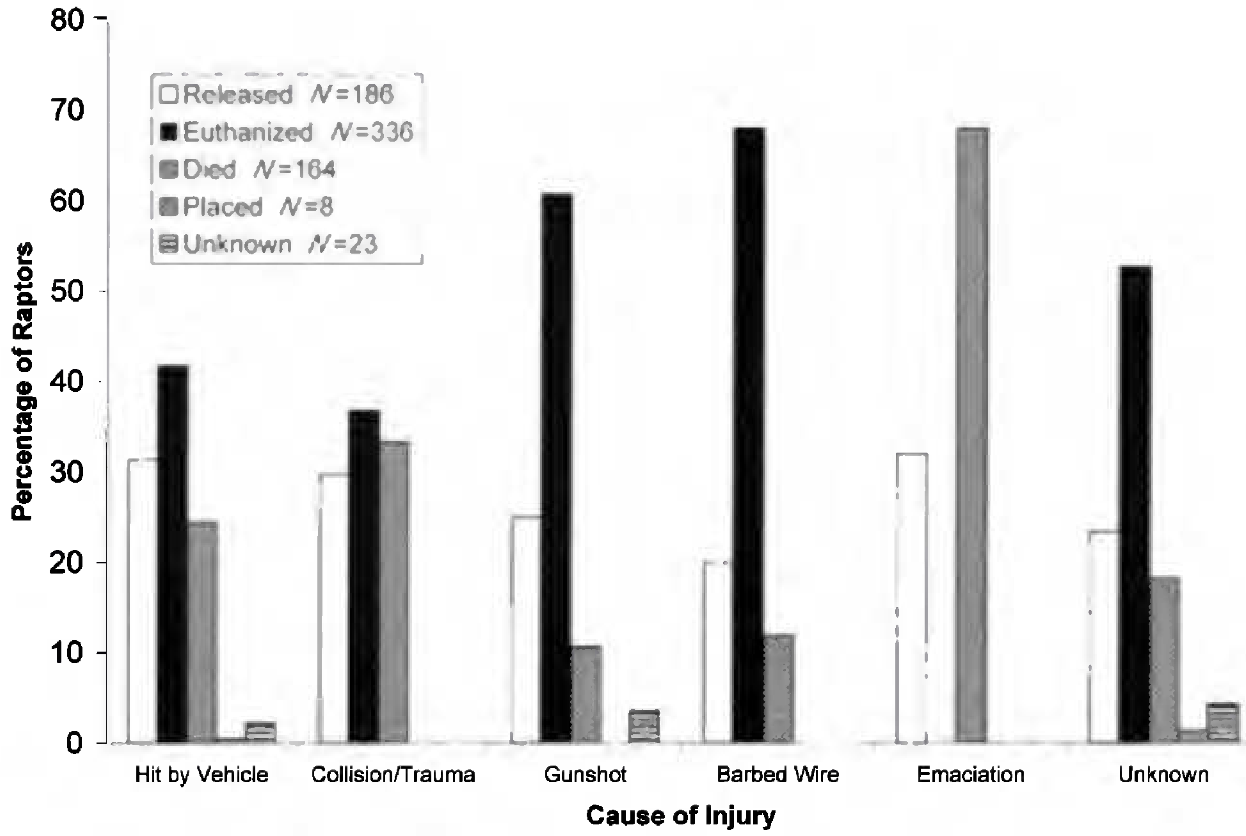

Figure 2. Cause of injuries to adult raptors admitted—Southeastern Raptor Rehabilitation Center from 1 January 1999–6 December 2000.

wire, emaciation) separately and pooled the rest into a single category of other causes for statistical analyses. Birds with unknown outcomes were omitted from consideration. The type of injury did not affect survival rates of birds (χ^2 = 5.2; df = 5; P = 0.38; Fig. 2). Data were insufficient to determine whether the cause of an injury played a significant role in determining whether a juvenile lived or died.

Diurnal adult birds had a much higher incidence of gunshot injuries and were slightly more likely to collide with windows than were nocturnal birds (χ^2 = 42.3, df = 4, $P < 0.0001$; Fig. 3). Additionally, body size and survi-

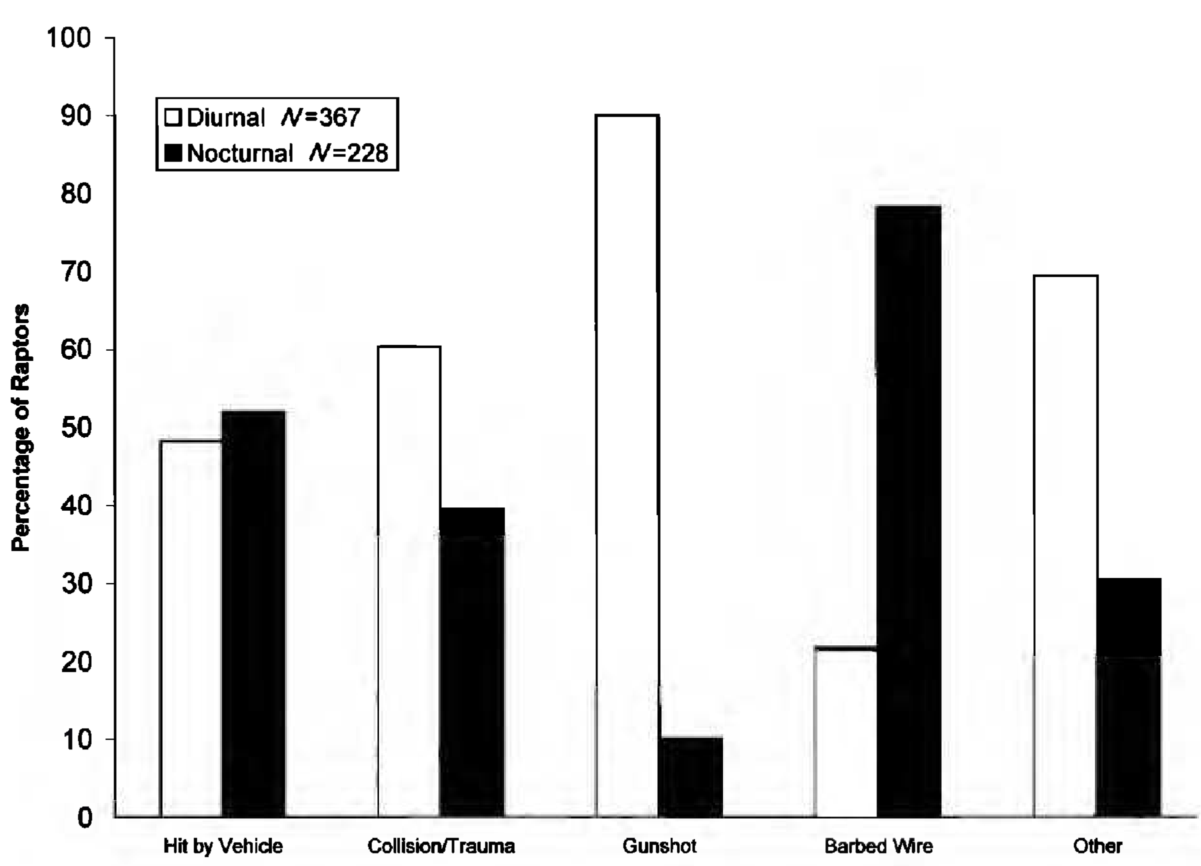

Figure 3. Effect of temporal activity on cause of injury of adult raptors processed by Southeastern Raptor Rehabilitation Center from 1 January 1999–6 December 2000. Birds admitted as a result of an unknown cause were omitted.

vorship of adults were negatively correlated (R^2 = 0.85, df = 4, P = 0.026; Survival = −0.018 [mass] + 45.88). For juveniles, there was no association between activity type (diurnal versus nocturnal) and type of injury (χ^2 = .35, df = 4, P = 0.99).

DISCUSSION

Our results suggest that activity patterns and body sizes of raptors in the southeastern United States are factors influencing the severity of injuries experienced by these birds. The overall degree of trauma experienced by nocturnal birds appears to be reduced (32.1% survival) relative to diurnal ones (22.6% survival). Similarly, small birds experience reduced trauma relative to large ones. Large, diurnal species are likely to be easier targets for certain injury types (e.g., gunshots), less maneuverable in escaping others (e.g., vehicles), and more prone to increased trauma due to greater inertia when hitting objects. Small, nocturnal species may have lower risks by being more difficult targets, more maneuverable in avoiding objects, and carrying less inertia when they do collide with objects. The pair of birds in our study that did not fit this overall pattern included Great Horned Owls (large bird with high survival) and Barred Owls (nocturnal bird with low survival). These two species differed principally in the greater frequency of collisions and greater variety of injury types experienced by Barred Owls. We suggest that additional data on mortality patterns will eventually demonstrate that some types of injury experienced largely by diurnal birds (e.g., gunshots), to be more severe than other injury types, resulting in higher mortality in these birds than nocturnal ones. Additionally, we suggest that behavioral differences (e.g., foraging strategy) of some nocturnal birds, like Barred Owls, may increase mortality relative to levels experienced by other nocturnal birds.

We found that survival of juveniles of all species is uniform and that this age group is released greater than 50% of the time at one large rehabilitation center. Juveniles typically are taken from nests rather than being found injured, and therefore, the primary rehabilitation goal is to feed and care for them until they are ready for independence. Our data indicate that juveniles of all species are equally responsive to the care given by SERRC. Because adults of these same species did not survive as well, we suggest that this is likely due to their ability to recover from injury and not to their propensity to accept care from humans.

Our results differ from those of Duke et al. (1981), who noted that hawks had higher release rates than owls, and that bird size had no effect on rehabilitation or release success. Similarly, our results do not agree with those of Fix and Barrows (1990), who found no significant difference among species in the occurrence of traumatic injuries. The conclusions reported documented in these studies suggest that the types of injuries experienced by birds differ among regions of the United States. Factors associated with road density, hunter training, local attitudes toward birds of prey, and habitat features might be important in explaining such trends.

Despite differences among published accounts, an overall pattern emerges from studies of records from raptor rehabilitation centers. These studies document that 21–30% of adult birds admitted to such facilities are released (Duke et al. 1981, Fix and Barrows 1990, Deem et al. 1998) and that most sources of injury are of anthropogenic origin (Keran 1981, Fix and Barrows 1990, Franson et al. 1996, Sweeney et al. 1997, Deem et al. 1998) One justification for rehabilitation efforts is that released birds represent animals that otherwise would have died. To understand how the release of rehabilitated raptors might contribute to the long-term conservation of raptor populations, much additional information is required.

RESUMEN.—Examinamos los registros que enumeraban las causas de lesión y la disposición final de 20 especies de rapaces (896 individuos) en el Centro de Rehabilitación de Rapaces del Sur oriente en Auburn, Alabama Estos datos son de 1 enero 1999 al 6 diciembre 2000. Las aves adultas y los juveniles (polluelos o aves que estaban emplumando y carecían de plumas de vuelo endurecidos) se consideraron por separado. A la mayoría de adultos les fue aplicada la eutanasia, mientras que la mayoría de juveniles fueron liberados. Las especies liberadas en mayores ocasiones fueron el búho chirreador oriental (*Otus asio*) (44.6%), seguido por el gavilán de Cooper (*Accipiter cooperii*) (37.8%), el gran búho cornudo (*Bubo virginianus*) (31.1%), y la lechuza de campanario (*Tyto alba*) (30.4%). En los juveniles, todas las especies tuvieron igual oportunidad de ser liberadas.

La causa principal de las lesiones en las aves adultas admitidas fue la colisión con vehículos (26.8%; excluyendo las heridas de origen desconocido). Esta y otras lesiones causadas por el hombre generalmente terminaron en la practica de la eutanasia mientras que otras aves murieron (71.1%; N = 804). La mayoría de los juveniles recibidos también fueron heridos por eventos de origen humano. La causa de las lesiones en los adultos variaron dependiendo si eran especies diurnas o nocturnas; la hora de de la actividad no tuvo efecto sobre el tipo de lesiones de los juveniles. En las aves adultas, las mas pequeñas fueron liberadas con mas frecuencia que las aves grandes. Este patrón no ocurrió con las aves juveniles.

[Traducción de César Márquez]

ACKNOWLEDGMENTS

We would like to thank the Southeastern Raptor Rehabilitation Center and the Auburn University College of Veterinary Medicine for access to their records. We thank two anonymous reviewers for comments that improved the presentation of the paper. This manuscript is derived from a thesis completed for the Honors College at Auburn University.

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Received 14 August 2002; accepted 20 August 2003
Associate Editor: Marco Restani

J Raptor Res. 38(1):81–85

BALD EAGLES CONSUME EMPEROR GEESE DURING LATE-WINTER IN THE ALEUTIAN ARCHIPELAGO

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KEY WORDS: *Bald Eagle;* Haliaeetus leucocephalus; *Emperor Goose,* Chen canagica; *food habits; Alaska; Aleutian Archipelago.*

Emperor Geese (*Chen canagica*) are a species of concern because their population has declined rapidly since the mid-1960s and continues to remain below management objectives (Petersen et al. 1994). Emperor Geese are restricted primarily to Alaska and exhibit an east-west migration pattern, whereby most birds begin breeding on the Yukon-Kuskokwim Delta by mid-May, stage on the Alaska Peninsula by late September, and migrate westward to winter in the Aleutian Archipelago from late November to mid-April (Eisenhauer and Kirkpatrick 1977, Petersen et al. 1994). Demographic and movement studies have been conducted on breeding grounds and staging areas (e.g., Schmutz et al. 1994, 1997); however, the winter ecology of Emperor Geese is poorly understood due in part to the extremely remote nature of the Aleutian Archipelago (Petersen et al. 1994).

Bald Eagles (*Haliaeetus leucocephalus*) are ubiquitous, year-round residents throughout the most of the Aleutian Archipelago (Murie 1959) and obtain most of their prey from the nearshore marine environment (Anthony et al 1999). We predict that Bald Eagles should prey on wintering Emperor Geese if available because eagles depredate other species of geese in southern latitudes (Frenzel and Anthony 1989, Watson et al. 1991, McWilliams et al 1994). However, the existing information on Bald Eagle predation of Emperor Geese appears contradictory. Sherrod et al. (1976) suggested geese may be too large for Bald Eagles to kill efficiently, and other studies rarely reported Emperor Geese as Bald Eagle prey in the Aleutians (Murie 1940, White et al. 1971, Sherrod et al. 1976) Conversely, Eisenhauer and Kirkpatrick (1977) stated that Bald Eagles are perhaps the dominant avian predator of wintering Emperor Geese, and cite the observa-

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